TECH

IMAGING

From Science Fiction to Medical Science

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It's the stuff of science fiction.

- Tiny cameras that go on fantastic voyages through the human body.
- Unmanned airplanes that transmit visual information.
- Imaging sensors implanted deep into the earth that enable scientists to map the underground world.

These are just a few of the areas being worked on in Idaho's growing imaging sector, a broad industry that encompasses everything from improving printing technology to new ways to view and target cancer.

Micron Technology, which has its worldwide headquarters in Boise, sells millions of tiny imaging sensors every week. The Complementary Metal Oxide Semiconductors – called CMOS sensors – are used in everything from making movies to automotive safety. While many Americans have likely never heard of CMOS sensors, they probably own one or two.

"The cell phone market is currently the largest for our imaging business," said Hisayuki Suzuki, senior director of marketing for Micron's imaging group. "In fact, Micron is one of the leading volume suppliers of image sensors designed into more than 95 percent of the handset supplier base."

While cell phones are the biggest market for Micron's CMOS image sensors, they have also made their mark on the medical industry by implanting their product in a consumable pill.

The PillCam, made by Given Imaging, is a camera the size of a multivitamin that takes pictures of a patient's gastrointestinal tract. The images are sent to a belt the patient wears, which is then downloaded for a doctor's examination. Micron continues to be the exclusive provider of the CMOS sensors for these products.

"Through our close collaboration with Given, we are enabling the company to continue its advancements in disposable medical imaging for detecting disorders of the gastrointestinal tract," said Suzuki.

A different type of medical imaging is being explored by a new firm led by Dr. Timothy Sawyer, medical director of cancer programs for St. Alphonsus Regional Medical Center in Boise. Sawyer's company, ImQuant Inc., is currently conducting medical trials in partnership with researchers at the Mayo Clinic on a technology that would allow scans – such as MRIs or PETs – to be read as a mathematical equation.

Sawyer believes he can greatly increase the targeting and effectiveness of cancer treatments by imaging cancerous tumors as data instead of as pictures.

AMI Semiconductor in Pocatello also has its eye on the medical imaging market. The firm produces custom imaging semiconductor chips that allow for more effective diagnosis for many medical problems, said Jon Stoner, senior vice president and chief technology officer.

"Our custom chips have enabled the CAT scan equipment manufacturers to increase the speed of their product dramatically without increasing the size or power produced by the product," said Stoner.

But the imaging sector includes much more than the medical field. Micron, for instance, makes high-speed image sensors that have been used for the production of movies such as "The Polar Express," "The Matrix" and all three Star Wars prequels.

The sensors capture images at speeds of more than 500 frames per second, with high megapixel resolution. Micron's success in this area has made it the primary image-sensor supplier to the two main high-speed camera vendors to Hollywood studios, said Suzuki.

Micron, once known only for being the manufacturer of dynamic random access memory – known as DRAM – for the computer industry, has used its image sensors to broaden its product offering. While still one of the world's largest makers of DRAM, it continues to expand the markets for its imaging products, now selling into a number of other markets, including industrial and automotive.

Likewise, AMI Semiconductor also sells its imaging chips into automotive, industrial and computer/consumer markets. It makes

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The imaging industry is one of Idaho's technology core competency areas as defined by the Governor's Science & Technology Advisory Council and the state Office of Science & Technology.

"By recognizing imaging as one of Idaho's technology strengths, we can build on it," said Karl Tueller, deputy director of Idaho Commerce & Labor and executive director of the Office of Science & Technology. "There's the potential to attract similar types of businesses here to take advantage of industry expertise."

The Office of Science & Technology in December released a "Core Competency Directory" listing companies and research institutions doing work in each of the four targeted areas – imaging, power and energy, ag/biotechnology, and nanotechnology and new materials.

The directory can be found online at technology.idaho.gov and click on "expertise."

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the actual imaging device that works in all-in-one printers to scan a picture or text and turn it into a digital image, and is the number one supplier in the world for CMOS linear imagers for the all-in-one printer industry. The firm also makes chips for everything from automatic teller machines to ballot and lottery scanners.

Stoner believes the imaging segment will continue to grow. “The technology is adaptable to many applications, from instrumentation – to improve detection of drugs, pollution, and for security – to industrial products, automotive and consumer products,” Stoner said.

The Idaho National Laboratory in Idaho Falls is researching and collaborating with industry in a number of novel ways to use and implement imaging technology.

For more than a decade, INL engineers have developed and demonstrated the use of lightweight, field deployable unmanned aerial vehicles for numerous applications, including imaging related work. In 2004, INL teamed up with the U.S. Forest Service and NASA to test small, thermal imaging sensor-equipped unmanned aerial vehicles as part of a program to evaluate potential fire-fighting support from small, robotic planes. Engineers and researchers were looking for reliable, user-friendly, technologies that could either improve the speed and safety, or decrease the cost of fire fighting.

Today’s big fires are mapped using manned aircraft, fitted with thermal sensors that fly at night over hot spots and fire perimeters. Data from the plane’s sensors is transmitted to staff at fire management operations centers who use the information to make decisions on when and where to send in equipment or firefighters. NASA teams from the Ames Research Center and Dryden Flight Research Center are investigating whether it makes sense to use flocks of small, inexpensive unmanned aerial vehicles carrying a variety of sensors for such routine observation.

Another INL imaging technology is the Hazmat Cam, a lightweight wireless video camera system that emergency first responder crews can carry into an incident scene.

The camera is housed in a tough, waterproof flashlight body and sends back live images to a command post located up to several miles away from the incident area. Before this device, emergency responders inside a hazardous area typically used two-way radios. The Hazmat Cam allows emergency crews to relay real-time information to the command center.

Designed by INL engineer Kevin Young, the device was named one of the most innovative products of the year in 2005 and was given the international R&D 100 award by R&D magazine.

Imaging research is also underway at Boise State University, in widely disparate areas of study. Michelle Sabick, co-director for the Center for Orthopaedic & Biomechanics Research at Boise State, uses imaging technology to help determine how athletes sustain injuries.

Using special software and computer vision algorithms, Sabick’s research team can animate the precise 3-D movements of individual bones relative to one another and understand the stresses that occur on joints when people jump or athletes throw a ball.

“We are still in the developmental stages, but when finished this will be useful both for research and clinical applications,” said Sabick. “In research, it will help us understand precisely how some complicated joints function. In clinical practice, it should be useful in diagnosing joint problems based on inappropriate movement patterns.

Boise State research professor Warren Barrash is studying ways to image what is below the Earth’s surface. The research will enable methods for predicting how contaminants move through the subsurface and designing subsurface clean-up systems.

“The basic idea is to send energy signals into the Earth and record the return of these signals,” said Barrash, director of the Boise Hydrogeophysical Research Site, Center for Geophysical Investigation of the Shallow Subsurface and Department of Geosciences. A change in signals can indicate contaminants and researchers can then model the flow of contaminant materials below the surface. The information then can be used to make better decisions about remediation efforts to remove polluting substances that affect the quality of drinking water, said Barrash.

“The potential for this research is significant,” he said. “Faster, cheaper, better ways to image the subsurface using geophysics can provide accurate descriptions of important subsurface features that otherwise are not apparent from the limited number of wells that may be drilled to sample. There is a growing awareness that imaging with largely non-invasive geophysical methods can guide and supplement the traditional invasive methods (wells) for investigating the subsurface.” **IQ**

This is a three-dimensional reconstruction of a woman’s leg bones created from a CT scan. The bones were identified in each image of the CT scan and then converted into a 3-D virtual object that can be rotated and viewed from any angle. Boise State researchers created the image using special medical image processing software. Photo courtesy of BSU Center for Orthopedic & Biomechanics Research

Vance Deason *The Image of Invention*

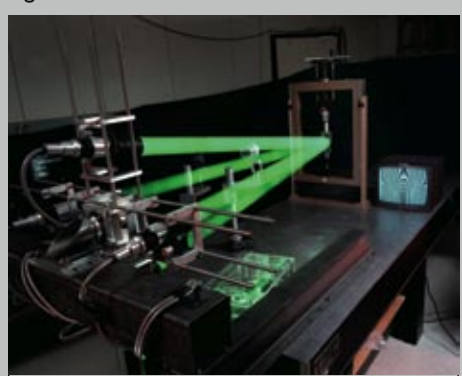
By Hannah Hickey

The first camera may have been invented more than 150 years ago, but Idaho scientist Vance Deason continues to devise imaging gadgets that, well, stretch the imagination.

In December, the physicist nabbed an award from Idaho National Laboratory as the first staff scientist to garner 15 patents. Deason has worked at the Idaho Falls lab for almost three decades devising new optical methods—and the instrumentation to make them shine.

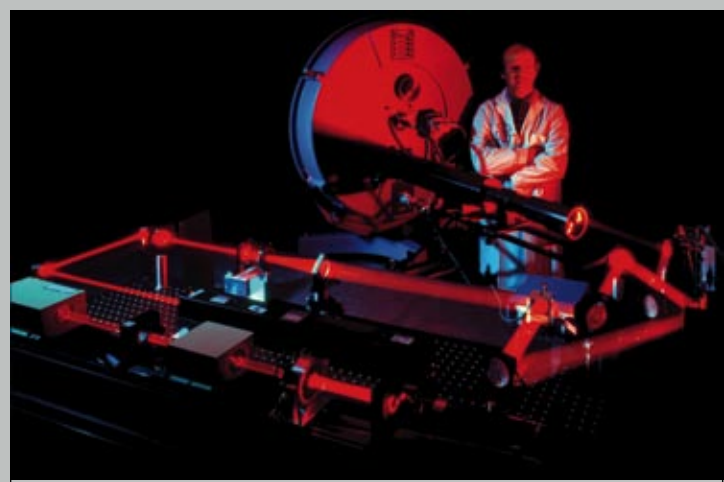
From his childhood in Colorado asking "wacky questions" to a physics education at the University of Colorado in Boulder, science and inventing provided an outlet for his curiosity. The onetime potter explains he was naturally drawn by the visual aspect of imaging research, a penchant also evident in his love of amateur photography.

For Deason, an invention usually starts out as an unsolved problem. He will learn of a measurement problem and think, "That's interesting—how would I do that?"



A split laser beam that measures tiny changes in an object under stress, patented by inventor Vance Deason.

Sometimes he stumbles on what he calls "motherloads": areas where not much research has been done, and "almost everything you do is new." Once he's developed a new imaging tool, he then looks for other possible applications.



Vance Deason in the late 1980's, standing behind his patented imaging device. A pulsing laser beam starts on the left, then strikes the object (right) from two different angles. The big circle in the center is a high-speed camera that records tiny deformations as the object is squeezed.

Deason struck a motherload more than once. His early inventions used moiré interferometers to watch how a material deforms in the instant during impact. By analyzing light and dark bands of light, the sensor detects stretching movements as tiny as a nanometer.

More recently, Deason collaborated on a series of patents with colleague Kenneth Telschow to develop ultrasonic microscopes. Like regular ultrasound, these measure high-frequency sound waves bouncing off objects to determine their internal structure. Unlike regular ultrasound, the user doesn't wait for a single returning echo. The device instead creates an image of all the vibrations reverberating on the object's surface. The resulting image has up to a million pixels, each of which is a simultaneous measurement. It can detect position or movements of less than a nanometer inside objects just a hair's width in size.

"It's an unusually complex set of technologies that have to come together," Deason says. "Scientifically, it's a pretty remarkable thing."

The physicist tries to perform measurements from an imaging point of view. Rather than taking a series of individual measurements, Deason's devices aim to "see" the whole object's characteristics at a single glance.

Receiving a $20,000 prize for his record-setting number of patents was nice recognition, he says. And Deason admits working at INL gives him the luxury to transform his ideas into patents.

"I could have a patentable idea every day, anyone can," he says. "But finding the support to develop the idea to the point where you can prove that it's workable—how many people have the opportunity to do that?" **IQ**

Photos courtesy of the Idaho National Laboratory